APPLICATION NOTE

Using IOS FIFO Feature for Sensor Hub

A-MCUAP3-ANGA04EN v1.1

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Revision History

Revision	Date	Description
1.0	March 2017	Initial release
1.1	April 12, 2022	Updated template

Reference Documents

Document ID	Description

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1

Introduction

Apollo/Apollo2 I^{2}C/SPI Slave Module (IO Slave or IOS) can be used to efficiently implement a Sensor Hub application, which acts as a central aggregator for data from multiple discrete sensors, and provides a single interface for Host applications (e.g., a smartphone).

Apollo's IOS module has a built-in FIFO interface which can support accumulating up to 1,023 bytes of data, independent of when the Host transfers the data out. The FIFO is implemented partially in the hardware (up to 128 Bytes[1]), with the overflow in the SRAM. At any point of time, the head of the queue is in the hardware FIFO, and the rest is stored in the SRAM.

The Hardware design of IOS allows for power efficient implementation of the FIFO. Read requests from Host are handled completely in the hardware, with the MCU involvement limited to replenishing the hardware FIFO (copying data from SRAM to hardware FIFO). The MCU is triggered by interrupts based on configurable hardware FIFO thresholds.

New data addition to the FIFO can work simultaneously with the Host reads. IOS provides FIFO visibility andcontrol to the Host through the I^{2}C/SPI interface by exposing special offsets in the IOS RAM, which can be accessed by the Host. Additionally, a direct access area can be provisioned in IOS for any out of band control exchange.

Since the FIFOCTR (which is the Host's view of the current FIFO Size available to read) is a multiple byte value, an explicit synchronization is needed between the Host and MCU to control access to updates to this value to ensure a consistent snapshot can be accessed by the Host.

An interrupt based synchronization mechanism is recommended for MCU to handshake the data transfer with the Host for optimized power efficiency. The Host can configure and enable explicit interface interrupts from MCU, which can be used to notify the Host of new data availability. For synchronization in the reverse direction, the Direct Access Area can be used by the Host to write messages for MCU, and a built-in interrupt mechanism (based on offset access) can be used to interrupt the MCU.

[1] For efficient use by Software, one byte of hardware FIFO space is wasted to distinguish the Empty from Full condition.

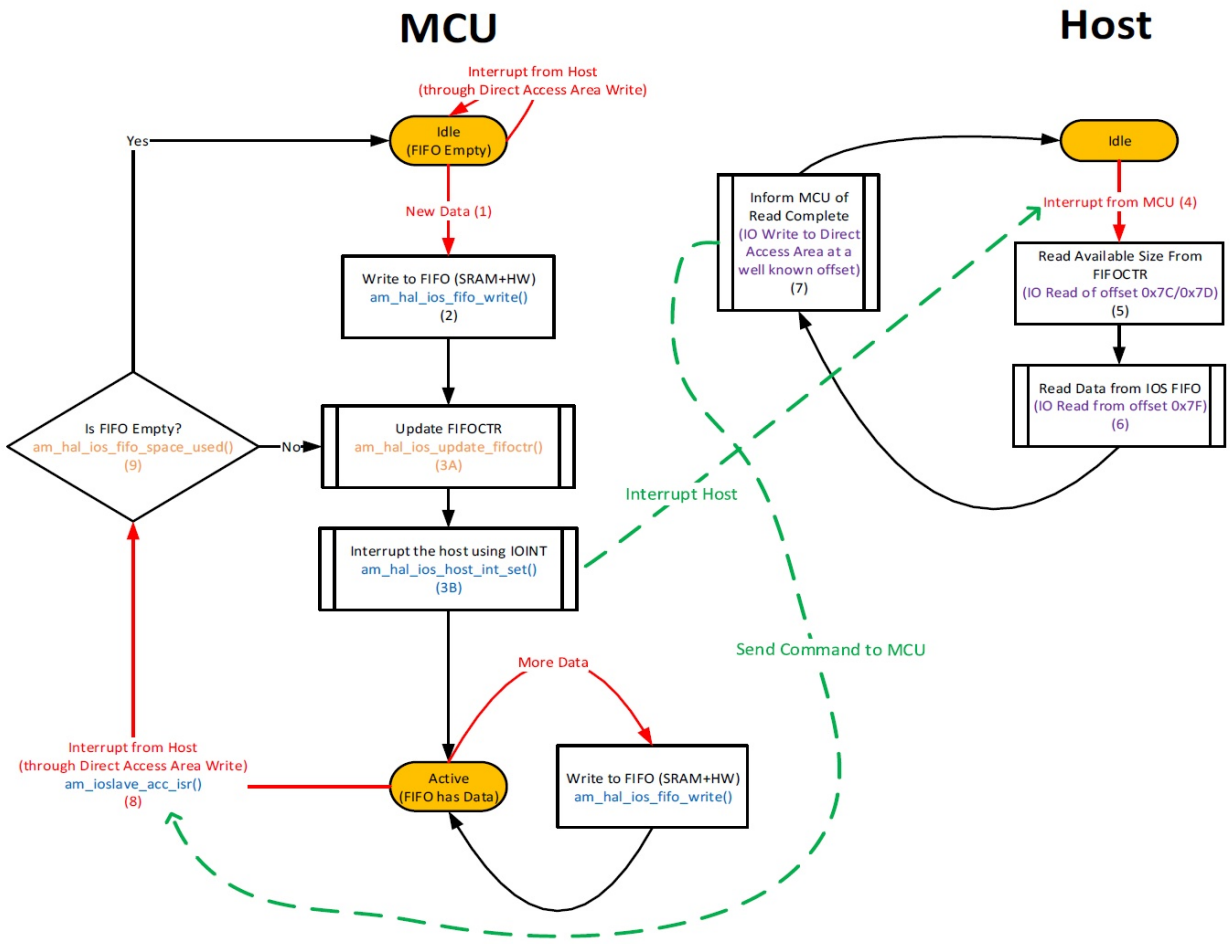
SECTION

2

Host and MCU Protocol

Figure 2-1 depicts a recommended protocol for data exchange between MCU and Host during active sensor data accumulation, and the same is described in detail below.

Figure 2-1: Host and MCU Protocol



SECTION

3

Using IOS FIFO Feature

During initialization, Host enables an interrupt from IOS by configuring the **IOINTEN** field in **IOINTCTL** register for MCU by writing to offset 0x78. This allows the MCU to interrupt the Host by writing to **IOINTSET** field in **IOINTCTL** register in IOS.

When IOS has some data for Host, it implements a state machine, synchronizing with the Host.

1. MCU receives new Data from Sensor(s) in the Idle state.
2. MCU writes the data to the FIFO (using `am_hal_ios_fifo_write()`).
3. MCU informs the Host of new data availability:
   a. MCU Updates the FIFOCTR to reflect the current FIFO size (using `am_hal_ios_update_fifoctr()`).
   b. MCU interrupts the Host by writing to **IOINTSET** field in **IOINTCTL** register in IOS, to indicate new data availability (using `am_hal_ios_host_int_set()`).

   MCU keeps accumulating any new data coming in the background (using `am_hal_ios_fifo_write()`).
4. Host receives interrupt from MCU
   a. Host reads the interrupt status by reading at offset 0x79 to confirm new data availability.
   b. Host clears the interrupt by writing to offset 0x7A.
5. Host reads the amount of available data to read (as indicated by **FIFOCTR**) by reading offset 0x7C/0x7D.
6. Host then reads the actual data by issuing one or more IO Read transactions on IOS FIFO through address 0x7F.
7. Host sends an acknowledgment message to IOS once it has finished reading a block of data initiated by IOS interrupt.
8. MCU is interrupted once the Host message is received (`am_ioslave_acc_isr()`)

   MCU interrupts the Host again if it has more data for the Host to read (and the cycle repeats), or else it goes back to 'Idle' state waiting for new data from the sensor(s).

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